







ORIGINAL RESEARCH

Short-Term Outcomes Following Left Atrial Appendage Closure in the Very Elderly: A Population-Based Analysis

Medhat Farwati , MD; Mustapha Amin, MD; Toshiaki Isogai , MD, MPH; Anas M. Saad , MD; Abdelrahman I. Abushouk , MD; Amar Krishnaswamy, MD; Oussama Wazni , MD; Samir R. Kapadia , MD

BACKGROUND: Data on percutaneous left atrial appendage closure (LAAC) outcomes in the very elderly with atrial fibrillation are limited. We aimed to investigate the clinical characteristics and short-term outcomes of patients 80 years or older following percutaneous LAAC in a large nationwide database.

METHODS AND RESULTS: Using the Nationwide Readmissions Database, we identified patients who underwent percutaneous LAAC between January 2016 and December 2018. Patients were categorized based on age (≥ 80 and < 80 years old). The primary outcome was in-hospital mortality. Secondary outcomes were in-hospital end points including periprocedural complications, 30-day outcomes, and all-cause 30-day readmissions. A propensity score–matched model (1:1) was used to adjust for baseline characteristics among the study groups. A total of 13 208 patients were included in this study (43% women, median age in years [interquartile range] 79.5 [73–84]) and matched one-to-one (6604 and 6604 patients were ≥ 80 and < 80 years old, respectively). In-hospital mortality was not statistically different between the study groups and occurred in 21 patients ≥ 80 years old (0.32%) and in 14 patients < 80 years old (0.21%); $P=0.236$. Rates of in-hospital stroke/transient ischemic attack were higher in patients ≥ 80 years old compared with those < 80 years old (1.22% versus 0.77%; $P=0.009$). In-hospital bleeding requiring transfusion, vascular complications, systemic embolization, and pericardial effusion/tamponade requiring pericardiocentesis or surgical intervention occurred more frequently in patients ≥ 80 years old. Furthermore, the elderly group was more likely to be readmitted within 30 days compared with those < 80 years old (9.91% versus 8.4%; $P=0.004$); however, rates of 30-day complications were not statistically different between the study groups.

CONCLUSIONS: In a large nationwide database, patients ≥ 80 years old undergoing percutaneous LAAC were found to have similar in-hospital mortality but an increased risk of periprocedural complications and 30-day readmission compared with younger patients. Our data suggest that LAAC should be considered on a case-by-case basis in the very elderly, taking into consideration the risks and benefits of this intervention. Further studies are needed to assess long-term LAAC outcomes in this high-risk population.

Key Words: atrial fibrillation ■ elderly ■ left atrial appendage closure ■ outcomes

Atrial fibrillation (AF) remains the most common arrhythmia in clinical practice, with a rising prevalence as the population ages.^{1–3} While oral

anticoagulation is the standard treatment for prevention of cerebrovascular events in patients with AF,^{2,4} percutaneous left atrial appendage closure (LAAC) has

Correspondence to: Samir R. Kapadia, MD, Department of Cardiovascular Medicine, Heart and Vascular Institute, Cleveland Clinic, 9500 Euclid Ave, J2-3, Cleveland, OH 44195. Email: kapadis@ccf.org

Presented in part at the American College of Cardiology meeting, Washington, DC, April 2–4, 2022, and published in abstract form (*Journal of the American College of Cardiology*. 79:596. [https://doi.org/10.1016/S0735-1097\(22\)01587-X](https://doi.org/10.1016/S0735-1097(22)01587-X)).

Supplemental Material is available at <https://www.ahajournals.org/doi/suppl/10.1161/JAHA.121.024574>

For Sources of Funding and Disclosures, see page 8.

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CLINICAL PERSPECTIVE

What Is New?

- In a large nationwide database, patients ≥ 80 years old undergoing percutaneous left atrial appendage closure were found to have similar in-hospital mortality compared with younger patients, with a reassuringly low rate in the overall population.
- Clinically significant periprocedural complications occurred more frequently in the elderly group.
- Patients ≥ 80 years old were at increased risk to be readmitted to the hospital within 30 days of their procedure.

What Are the Clinical Implications?

- Our findings suggest that left atrial appendage closure should be considered on a case-by-case basis in the very elderly, taking into consideration the risks and benefits of this intervention.

Nonstandard Abbreviations and Acronyms

LAAC	left atrial appendage closure
NRD	Nationwide Readmissions Database

gained wide acceptance as an effective intervention to prevent stroke in those who have contraindication to long-term anticoagulation.^{5,6}

Elderly patients with AF represent a uniquely vulnerable population because of an increased risk of both thromboembolic and bleeding events.^{5,7} In the Framingham study, $\approx 24\%$ of strokes attributed to AF occurred in patients ≥ 80 years old and many of these patients were at elevated bleeding risk.⁸ Therefore, percutaneous LAAC may be considered an appealing alternative to pharmacologic anticoagulation in this population. Yet, data on LAAC outcomes in the very elderly (≥ 80 years old) are limited. Moreover, this group of patients has been underrepresented in the landmark LAAC device trials that led to its Food and Drug Administration approval, with a mean age of 71.8 years in the PROTECT AF (WATCHMAN Left Atrial Appendage System for Embolic Protection in Patients With Atrial Fibrillation) trial and 74 years in the PREVAIL (Prospective Randomized Evaluation of the WATCHMAN LAA Closure Device in Patients With Atrial Fibrillation (AF) Versus Long-Term Warfarin Therapy) trial.^{9,10} In this study, we aimed to investigate the clinical characteristics, in-hospital, and 30-day outcomes

of patients ≥ 80 years old in comparison to younger patients following percutaneous LAAC from a large nationwide database.

METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Data Source

We identified patients who received percutaneous LAAC between January 2016 and December 2018 using the Nationwide Readmissions Database (NRD) following the Strengthening the Reporting of Observational Studies in Epidemiology checklist for retrospective cohort study design.¹¹ The NRD was developed by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project. The NRD contains longitudinal patient data on roughly half of all hospitalizations in the United States, as well as their outcomes and readmissions. It utilizes the *International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)*, procedure codes, and Clinical Classification Software codes, which organize multiple *ICD-10-CM* codes into clinically relevant categories for more efficient analysis.¹²

The study was exempted by the Institutional Review Board at our institution because only de-identified patient information was used for analysis.

Study Population and Patient Characteristics

Patients who underwent the percutaneous LAAC procedure (*ICD-10-CM* 02L73DK) were identified in the NRD. Patients were categorized based on age (≥ 80 and < 80 years old). Patients < 18 years old ($n=4$), and those with missing vital status ($n=2$) or length of stay ($n=1$) were excluded.

We used the Elixhauser comorbidity index along with *ICD-10* codes to identify baseline characteristics, comorbid conditions (heart failure, valvular heart disease, prior coronary artery disease, prior cerebrovascular accident, peripheral vascular disease, end-stage renal disease, chronic kidney disease, chronic pulmonary disease, diabetes, hyperlipidemia, hypertension, obesity, and smoking), in-hospital outcomes, and 30-day outcomes (in-hospital mortality, stroke/transient ischemic attack, bleeding requiring transfusion, vascular complications, systemic embolization, pericardial effusion/tamponade, pericardial effusion/tamponade requiring intervention, acute kidney injury, and length of stay) (Table S1). Acute kidney injury was defined based on the *ICD-10-CM* Diagnosis Code N17. Smoking status included both active and former smokers.

Outcomes Measured

The primary outcome was in-hospital mortality. Secondary outcomes were in-hospital outcomes including periprocedural complications, 30-day outcomes, and all-cause 30-day readmissions. Healthcare Cost and Utilization Project methodology was utilized to identify readmissions.¹³ Thirty-day readmission outcomes in patients who underwent LAAC procedures in December of each year were not available for this analysis because NRD can only track patients' data within the same calendar year.

Time to readmission was also calculated by subtracting the readmission date from the index discharge date. For patients who had repeated readmissions within the first 30 days, only the first readmission was considered. The primary diagnosis code of readmission was considered the main reason for rehospitalization.

To ascertain the main reasons for readmission, 2 independent investigators assessed the primary diagnosis code of every readmission and classified them into clinically relevant groups. Conflicts were settled by mutual agreement. Readmission causes were grouped into cardiac, bleeding, infection, neurological, gastrointestinal, respiratory, renal, hematological or neoplasm, and others. Cardiac-related causes included heart failure, AF, coronary artery disease, arrhythmias (excluding AF), conduction disorders, and others.

Statistical Analysis

Categorical variables were expressed as numbers and proportions, and continuous variables were expressed as mean±SD or median (interquartile range). Pearson χ^2 test or the Fisher exact test was used to compare proportions, and the ANOVA or the nonparametric Kruskal–Wallis tests were used to compare continuous variables, as appropriate.

Independent predictors of in-hospital mortality and in-hospital stroke were assessed using a multiple logistic regression model including age, sex, admission status (elective versus nonelective), heart failure, prior myocardial infarction, prior cardiac surgery, AF, prior cerebrovascular accident, chronic kidney disease, end-stage renal disease, chronic pulmonary disease, smoking, diabetes, hypertension, dyslipidemia, obesity, and peripheral vascular disease. The findings of logistic regression were reported using the odds ratio (OR) and the 95% CI.

A propensity score–matched model (1:1) was utilized to adjust for differences in baseline characteristics between patients ≥ 80 and < 80 years old. Patients were matched 1:1 to the closest match with a caliper of 0.1. A multivariate logistic regression model was used to obtain propensity scores. Variables included in the model were sex, admission status (elective versus nonelective), heart failure, prior myocardial infarction,

prior cardiac surgery, AF, prior cerebrovascular accident, chronic kidney disease, end-stage renal disease, chronic pulmonary disease, smoking, diabetes, hypertension, dyslipidemia, obesity, and peripheral vascular disease. We calculated the absolute mean differences for covariates after matching. Minimal match imbalances were defined as absolute mean differences of < 0.1 . Statistical analysis was performed with IBM SPSS Statistics 20.0 (IBM Corp, Armonk, NY). A 2-sided $P < 0.05$ was considered statistically significant.

RESULTS

Baseline Characteristics

A total of 13 208 patients who underwent percutaneous LAAC between 2016 and 2018 were included in this study (43% women, median age in years [interquartile range] 79.5 [73–84]) and matched one-to-one (6604 and 6604 patients were ≥ 80 and < 80 years old, respectively). Absolute standardized differences were < 0.1 for the variables entered in the propensity match model, indicating successful adjustment for baseline characteristics between the 2 groups. Nearly 90% of the admissions for LAAC placement were elective in this study. Median CHA₂DS₂-VASc score was 4 for both groups. Baseline characteristics for the study population are summarized in [Table 1](#).

In-Hospital Outcomes

In-hospital mortality was not statistically different between the study groups and occurred in 21 patients ≥ 80 years old (0.32%) and in 14 patients < 80 years old (0.21%); $P = 0.236$. Rates of in-hospital stroke/transient ischemic attack were higher in patients ≥ 80 years old compared with those < 80 years old (1.22% versus 0.77%; $P = 0.009$). Furthermore, secondary in-hospital outcomes occurred more frequently in patients ≥ 80 years old compared with younger patients including bleeding requiring transfusion (2.74% versus 2.2%; $P = 0.043$), vascular complications (3.3% versus 2.37%; $P = 0.001$), systemic embolization (0.18% versus 0.0%; $P = 0.021$), and pericardial effusion/tamponade requiring pericardiocentesis or surgical intervention (1.36% versus 0.87%; $P = 0.008$). Rates of acute kidney injury were similar between the age groups (2.72% versus 2.68%; $P = 0.872$). Although the mean length of stay (in days) was not statistically different between the study groups (1.5±2.66 in ≥ 80 years old versus 1.55±2.5 in < 80 years old; $P = 0.253$), more patients were hospitalized for > 2 days in the elderly group (8.17% versus 6.93%; $P = 0.007$). In-hospital outcomes for the study population are summarized in [Table 2](#).

In multivariable analysis adjusting for age, sex, baseline clinical characteristics, and type of admission (elective versus nonelective) in patients ≥ 80 years old,

Table 1. Baseline Characteristics of Patients Undergoing Left Atrial Appendage Closure Stratified by Age*

Demographic/variable	<80 y (n=6604)	≥80 y (n=6604)	Total (n=13 208)	Absolute standardized difference
Age, y	73 (69–77)	84 (81–86)	79.5 (73–84)	...
Female	2829 (42.8)	2851 (43.2)	5680 (43)	0.006
Elective admission	6023 (91.2)	5915 (89.6)	11 938 (90.4)	0.045
Diabetes	1871 (28.3)	1841 (27.9)	3712 (28.1)	0.007
Hypertension	5757 (87.2)	5694 (86.2)	115 451 (86.7)	0.024
Chronic kidney disease	1386 (21)	1426 (21.6)	2812 (21.3)	0.012
ESRD	77 (1.2)	114 (1.7)	191 (1.4)	0.033
Dyslipidemia	4072 (61)	4015 (60.8)	8042 (60.9)	0.003
Chronic pulmonary disease	1111 (16.8)	11 194 (18.1)	2305 (17.5)	0.028
Atrial fibrillation	6597 (99.9)	6595 (99.9)	13 192 (99.9)	0
Prior MI	624 (9.4)	738 (11.2)	1362 (10.3)	0.048
Prior cardiac surgery	1257 (19)	1355 (20.5)	2612 (19.8)	0.031
Obesity	514 (7.8)	530 (8)	1044 (7.9)	0.006
Prior CVA	1554 (23.5)	1640 (24.8)	3194 (24.2)	0.025
Heart failure	2165 (32.8)	2229 (33.8)	4394 (33.3)	0.017
Smoking	2303 (34.9)	2294 (34.7)	4597 (34.8)	0.003
PVD	598 (9.1)	697 (10.6)	1295 (9.8)	0.041
CHA ₂ DS ₂ -VASc score, median (IQR)	4 (3–5)	4 (4–6)	4 (3–5)	N/A

Values are n (%), mean±SD, or median (interquartile range). CVA indicates cerebrovascular accident; ESRD, end-stage renal disease; IQR, interquartile range; MI, myocardial infarction; N/A, not applicable; and PVD, peripheral vascular disease.

*Variables included in the propensity-score matched model were sex, admission status (elective vs nonelective), heart failure, prior myocardial infarction, prior cardiac surgery, atrial fibrillation, prior cerebrovascular accident, chronic kidney disease, end-stage renal disease, chronic pulmonary disease, smoking, diabetes, hypertension, dyslipidemia, obesity, and peripheral vascular disease.

Table 2. In-Hospital Outcomes of Patients Undergoing Left Atrial Appendage Closure Stratified by Age

Outcome	<80 y (n=6604)	≥80 y (n=6604)	Total (n=13 208)	P value*
In-hospital mortality	14 (0.21)	21 (0.32)	35 (0.26)	0.236
Stroke/TIA	51 (0.77)	81 (1.22)	132 (0.99)	0.009
Bleeding requiring transfusion	145 (2.2)	181 (2.74)	326 (2.46)	0.043
Vascular complications	157 (2.37)	218 (3.3)	375 (2.83)	0.001
Systemic embolization	≤10 (≤0.15) [†]	12 (0.18)	15 (0.11)	0.021
Pericardial effusion/tamponade	175 (2.64)	221 (3.34)	396 (2.99)	0.019
Pericardial effusion/tamponade requiring pericardiocentesis/surgical intervention	58 (0.87)	90 (1.36)	148 (1.12)	0.008
Acute kidney injury	177 (2.68)	180 (2.72)	357 (2.7)	0.872
Death or major complication [‡]	553 (8.37)	668 (10.12)	1221 (9.24)	<0.001
Length of stay, d	1.5±2.66	1.55±2.5	1.52±2.58	0.253
Length of stay >2 d (%)	458 (6.93)	540 (8.17)	998 (7.55)	0.007

Values are n (%) or mean±SD. TIA indicates transient ischemic attack.

*Pearson χ^2 test or the Fisher exact test (for $n < 10$) was used to compare proportions, and the ANOVA or the nonparametric Kruskal–Wallis tests were used to compare continuous variables, as appropriate.

[†]Categorical variable cell with $n \leq 10$ was suppressed in compliance with the privacy protection policy of the Healthcare Cost and Utilization Project Data Use Agreement.

[‡]Defined as in-hospital mortality, stroke/TIA, bleeding requiring transfusion, vascular complications, systemic embolization, pericardial effusion/tamponade, or acute kidney injury.

end-stage renal disease was found to be an independent predictor of in-hospital mortality (OR, 14.19 [95% CI, 3.36–54.91]; $P < 0.001$) (Table S2), whereas elective

admission was associated with lower incidence of in-hospital stroke/transient ischemic attack (OR, 0.21 [95% CI, 0.13–0.33]; $P < 0.001$) (Table S3).

Thirty-Day Outcomes and Causes of 30-Day Readmission

Of 11 897 patients who underwent LAAC and survived their index hospitalization, 1090 (9.16%) were readmitted within 30 days. Patients ≥ 80 years old were more likely to be readmitted compared with those ≤ 80 years old (9.91% versus 8.4%; $P=0.004$). Rates of 30-day outcomes were not statistically different between the study groups including bleeding requiring transfusion, vascular complications, systemic embolization, and pericardial effusion/tamponade requiring pericardiocentesis or surgical intervention (Table 3).

The most common causes for 30-day readmission in patients ≥ 80 years old were bleeding (28.1%), cardiac (24.7%), and infection (15.1%). In younger patients, cardiac-related readmissions were the most common (30.9%) followed by bleeding (22.2%) and infection (15.4%) (Figure 1). Cardiac causes of 30-day readmission were generally comparable between patients ≥ 80 years old and those < 80 years old and included congestive heart failure (52% versus 44%), coronary artery disease (9.6% versus 7%), AF (14.4% versus 27%), and other arrhythmia/conduction disorders (10.3% versus 10%), respectively (Figure 2).

DISCUSSION

In the current study from the NRD, we report on the clinical characteristics, in-hospital, and 30-day outcomes of patients ≥ 80 years old in comparison to younger patients following percutaneous LAAC. The principal findings of this report are the following: (1) In-hospital mortality was comparable between patients ≥ 80 years and those < 80 years old with a reassuringly low rate in the overall population. (2) Clinically

significant periprocedural complications occurred more frequently in the elderly group. and (3) Patients ≥ 80 years old were at increased risk to be readmitted to the hospital within 30 days of their procedure.

It is well established that elderly patients with AF have greater thromboembolic risk, are more prone to bleeding events, and are more likely to have comorbidities that present a relative or absolute contraindication to anticoagulation therapy.^{14,15} Therefore, percutaneous LAAC represents an attractive option for stroke prevention for these patients. Yet, the major WATCHMAN clinical trials included only small numbers of patients > 80 years old,^{9,10} with a paucity of real-world data assessing LAAC outcomes in this vulnerable population.¹⁶

In this large nationwide cohort, we found that patients ≥ 80 years old had a low in-hospital mortality rate following LAAC, similar in magnitude to their younger counterparts. Interestingly, end-stage renal disease appeared to be an independent risk factor for in-hospital mortality in multivariable analysis in older patients. This observation is in line with a recent study from a contemporary nationwide database demonstrating that patients on dialysis fare worse following LAAC.¹⁷ As such, special attention needs to be paid for this group of patients to reduce mortality and morbidity. Unlike mortality, however, elderly patients were at increased risk of in-hospital complications compared with younger patients including stroke/transient ischemic attack, bleeding requiring transfusion, vascular complications, systemic embolization, and pericardial effusion/tamponade requiring pericardiocentesis or surgical intervention. Prior literature on outcomes of the LAAC devices in the very elderly is scarce. While previous smaller studies have found that the incidence of periprocedural complications following LAAC may

Table 3. Thirty-Day Outcomes of Patients Undergoing Left Atrial Appendage Closure Stratified by Age*

Outcome	< 80 y (n=5935)	≥ 80 y (n=5962)	Total (n=11 897)	P value [†]
All cause 30-d readmission	499 (8.4)	591 (9.91)	1090 (9.16)	0.004
Stroke/TIA	29 (0.49)	26 (0.44)	55 (0.46)	0.673
Bleeding requiring transfusion	93 (1.57)	136 (2.28)	229 (1.92)	0.077
Vascular complications	135 (2.27)	164 (2.75)	299 (2.51)	0.097
Systemic embolization	0 (0)	≤ 10 (≤ 0.16) [‡]	≤ 10 (≤ 0.084) [‡]	1
Pericardial effusion/tamponade	20 (0.34)	21 (0.35)	41 (0.34)	0.887
Pericardial effusion/tamponade requiring pericardiocentesis/surgical intervention	11 (0.19)	14 (0.23)	25 (0.21)	0.556
Any major complication [§]	208 (3.5)	249 (4.18)	457 (3.84)	0.063

Values are n (%). TIA indicates transient ischemic attack.

*Among patients discharged alive between January and November in each calendar year.

[†]Pearson χ^2 test or the Fisher exact test (for $n < 10$) was used to compare proportions, and the ANOVA or the nonparametric Kruskal–Wallis tests were used to compare continuous variables, as appropriate.

[‡]Categorical variable cell with $n \leq 10$ was suppressed in compliance with the privacy protection policy of the Healthcare Cost and Utilization Project Data Use Agreement.

[§]Defined as stroke/TIA, bleeding requiring transfusion, vascular complications, systemic embolization, or pericardial effusion/tamponade.

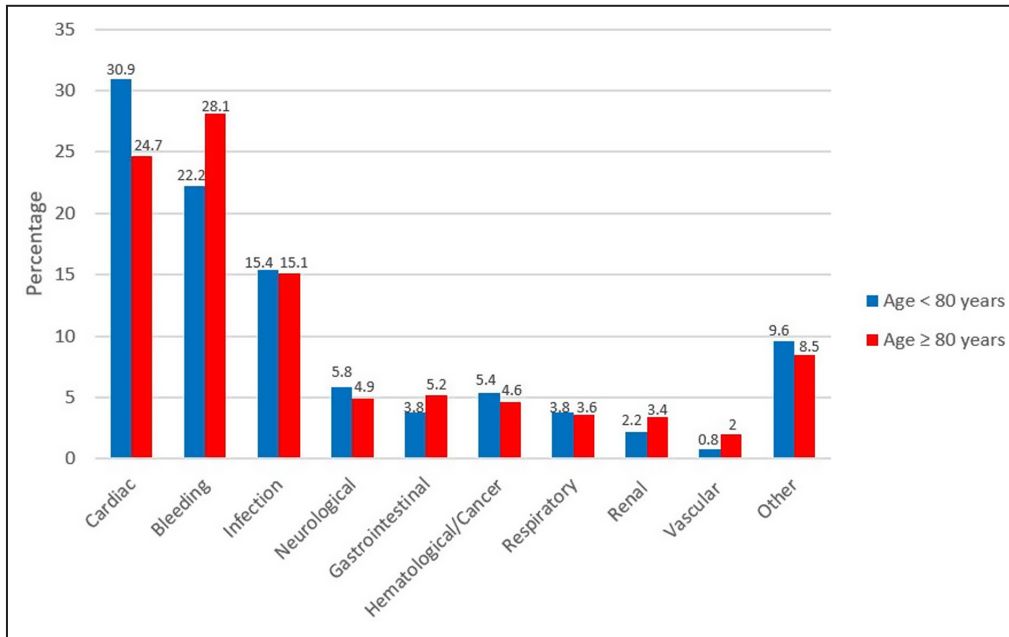


Figure 1. Causes of 30-day readmissions after left atrial appendage closure stratified by age ≥80 vs <80 years old.

“Other” includes musculoskeletal, endocrine, and metabolic.

be similar in older and nonelderly patients,^{18,19} more recent evidence suggests that the risk of adverse events increases with age.⁶ In a small study of 84 patients ≥85 years old from the EWOLUTION (Evaluating Real-Life Clinical Outcomes in Atrial Fibrillation Patients Receiving the Watchman Left Atrial Appendage Closure Technology) registry, there was no observed

difference in periprocedural mortality or complications compared with patients <85 years old.¹⁹ It is important to note, however, that the sample size of the above-mentioned study is substantially less than that of the current analysis, making it likely underpowered to detect differences in outcomes. In contrast, a recent study from the National Inpatient Sample demonstrated that

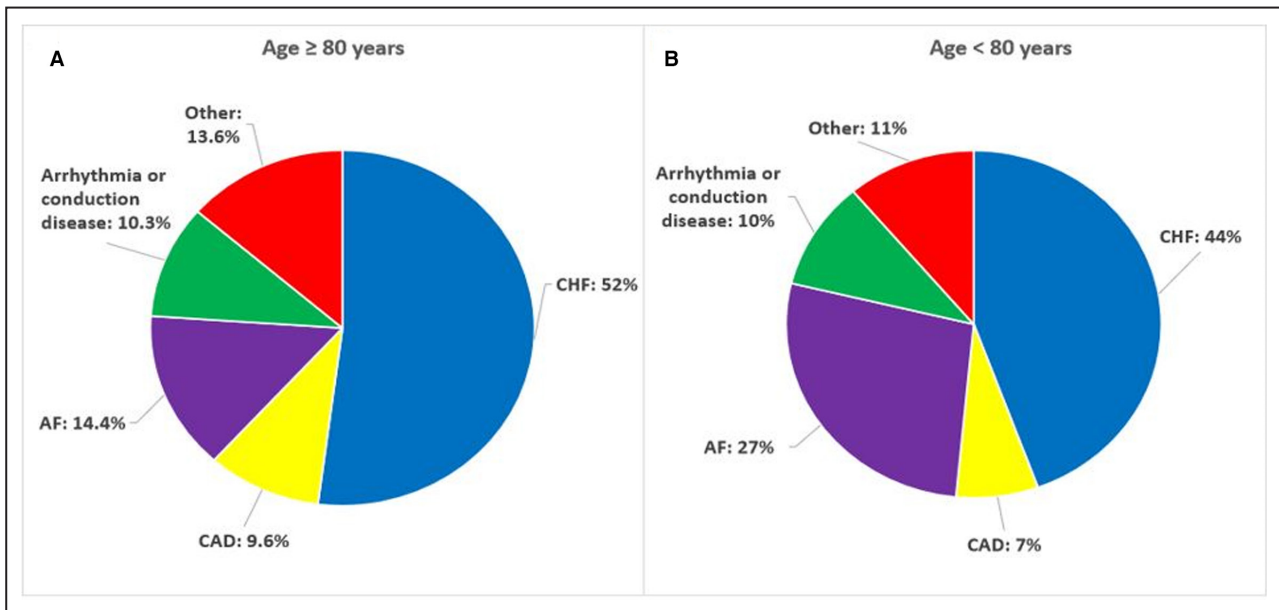


Figure 2. Illustration of cardiac-related causes of 30-day readmissions after left atrial appendage closure.

A, In patients ≥80 years old. **B,** In patients <80 years old. AF indicates atrial fibrillation; CAD, coronary artery disease; and CHF, congestive heart failure. “Other” includes pericardial disease, valvular heart disease, hypertension, hypotension, and complication of cardiac prosthetic devices.

patients ≥ 80 years old experienced higher rates of in-hospital complications as compared with patients who are < 80 years old.⁶ The current study adds to this line of evidence that LAAC in the very elderly might indeed present higher risk for in-hospital complications. In addition, the present analysis provides more data about 30-day readmission rates and causes for rehospitalization following LAAC. While the 30-day readmission rate for the overall population was $< 10\%$, patients ≥ 80 years old were at slightly higher risk for readmission compared with < 80 years old. Notably, bleeding complications were the main drivers for readmission in patients ≥ 80 years old. This is likely a reflection of the overall frailty and predisposition to bleeding in the very elderly as well as the fact that many patients potentially still receive warfarin and aspirin for 45 days following LAAC device implantation based on the treatment protocols from the PROTECT AF and PREVAIL trials.^{9,10} Nonetheless, alternative antithrombotic regimens following LAAC have been described in the literature,²⁰ and anticoagulant use after device implantation varies greatly between sites.²¹ Further prospective studies are needed to define the optimal postprocedural anticoagulation/antiplatelet regimen, particularly in the very elderly with elevated bleeding risk.

Overall, it is encouraging that the rate of complications was low in this study with relatively small difference in absolute event rates across both age groups. Taken together, LAAC may still be performed safely in the elderly and should be considered on a case-by-case basis, taking into consideration the risks and benefits of this intervention in light of available evidence. As the experience with LAAC continues to grow, further research is needed to better characterize the risk for complications and the long-term outcomes of this procedure in elderly patients.

Limitations

The current study should be interpreted in the context of some limitations. First, our findings are derived from an administrative claims database and limited by the available data in the NRD. Lacking information include laboratory values, anticoagulation status, imaging findings, and procedural/device characteristics. Therefore, it is not possible to determine the impact of these variables on the study outcomes. Similarly, information on attempted but not successfully implanted devices are not available in the NRD and therefore only implanted procedures were included in this analysis. It is possible that failures to implant may be because of major and life-limiting complications that cannot be accounted for in this database. Thus, the results of this nonrandomized study closely resemble an “as-treated analysis.” Second, although we used propensity score matching to reduce heterogeneity

between the 2 study groups, confounding by indication and selection bias cannot be excluded in this retrospective analysis. Third, the threshold to code certain complications such as “pericardial effusion” is not universal across hospitals, which may have resulted in some event misclassification. We, therefore, included a separate end point for pericardial effusion requiring pericardiocentesis or surgical intervention, because this outcome is ascertained based on procedural codes and is less likely to be miscoded. Fourth, it is possible that elderly and nonelderly patients might have died from different causes following LAAC implantation; however, the causes of mortality, both in-hospital and at 30-days, are not available in the NRD. Fifth, despite its large sample size, the current study may not be adequately powered to detect differences in outcomes with low event rates including in-hospital mortality and 30-day outcomes. Finally, the present analysis was restricted to short-term outcomes because the NRD does not include follow-up and long-term data. Thus, the extended outcomes of LAAC in the very elderly are uncertain. Nonetheless, this study leverages a large sample size and real-world data to provide much needed insight on the in-hospital and short-term outcomes of LAAC in the very elderly.

CONCLUSIONS

In a large nationwide database, patients ≥ 80 years old undergoing percutaneous LAAC were found to have similar in-hospital mortality but an increased risk for periprocedural complications and 30-day readmission compared with younger patients. The overall rate of complications was low, with relatively small difference in absolute event rates across both age groups. Our data suggest that LAAC should be considered on a case-by-case basis in the very elderly, taking into consideration the risks and benefits of this intervention. Further studies are needed to assess long-term LAAC outcomes in this high-risk population.

ARTICLE INFORMATION

Received November 12, 2021; accepted April 21, 2022.

Affiliations

Department of Internal Medicine (M.F., M.A.) and Heart and Vascular Institute (T.L., A.M.S., A.I.A., A.K., O.W., S.R.K.), Cleveland Clinic, Cleveland, OH

Sources of Funding

This study was made possible by a generous gift from Jennifer and Robert McNeil.

Disclosures

Dr Wazni receives consulting fees from Boston Scientific. The other authors report no conflicts of interest.

Supplemental Material

Tables S1–S3

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SUPPLEMENTAL MATERIAL

Table S1: International Classification of Diseases Codes Used to Define Baseline Variables, In-Hospital and Thirty Day Outcomes, and Procedures.

Diagnosis/codes	ICD-10 codes
Heart Failure	I11.0, I50.1, I50.2x, I50.3x, I50.4x, I50.81x, I50.82, I50.83, I50.84, I50.89, I50.9
Dyslipidemia	E78.0, E78.00, E78.01, E78.1, E78.2, E78.3, E78.4, E78.5, E78.81, E78.89, E78.9
Chronic Kidney Disease	N18.1, N18.2, N18.3, N18.4, N18.5, N18.9
End Stage Renal Disease	N18.6
History of Coronary Artery Disease	Z95.1, I25.7xx, I25.810, I25.812, I25.2, I22.0, I22.1, I22.2, I22.8, I22.9, Z95.5, Z98.61
Prior Cerebrovascular Accident	Z867.3, I699.10, I699.11, I699.13, I699.15, I699.14, I699.18, I699.19
Smoking	Z72.0, Z87.891, F17.200 to F17.229, F17.290, F17.293, F17.298, F17.299
Acute Kidney Injury	N17.x
Stroke	I60.xx, I61.x, I62.xx, I63.xxx, I64.xx
TIA	G45.xx
Prior Cardiac Surgery	I25.700, I25.708, I25.709, I25.71, I25.72, I25.73, I25.76, I25.79, I25.810, I25.812, Z95.1, Z952, Z953, Z954
Vascular Complications	I97.410, I97.418, I97.610, I97.618, I97.620, I97.631, I97.638, D62, S09.0xxA S15, S25, S35, S45, S55, S65, S75, S85, S95,

	T11.4, T13.4, I97.51, I97.52, I77.0, T80.1XXA, T81.710A, T81.711A, T81.718A, T81.72XA
Systemic Embolization	I74.xx, I75.xx, N28.0, K55.011, K55.021, K55.031, K55.041, K55.051, K55.061
Pericardial Effusion/Tamponade	I31.4, I31.3
Procedure Codes	
Percutaneous Left Atrial Appendage Closure	02L73DK
Blood Transfusion	30233H0, 30233N0, 30243H0, 30243N0, 30233H1, 30243H1, 30233N1, 30233P1, 30243N1, 30243P1, 30233R1, 30243R1, 30233T1, 30233V1, 30233W1, 30243T1, 30243V1, 30243W1, 30233J1, 30233K1, 30233L1, 30233M1, 30243J1, 30243K1, 30243L1, 30243M1, 3E033GC, 3E043GC, 3E053GC, E063GC, 30233Q1, 30243Q1, 30233W0, 30243W0
Pericardiocentesis/ Pericardial Surgery	02CN0ZZ, 02NN0ZZ, 0W9D00Z, 0W9D0ZX, 0W9D0ZZ, 0WCD0ZZ, 0W9C30Z, 0W9C3ZZ, 0W9D30Z, 0W9D3ZX, 0W9D3ZZ, 0W9D40Z, 0W9D4ZX, 0W9D4ZZ, 02N60ZZ, 02N70ZZ, 02NK0ZZ, 02NL0ZZ, 02C60ZZ, 02C70ZZ, 02C80ZZ, 02C90ZZ, 02CK0ZZ, 02CL0ZZ, 02PA0YZ, 02WA0YZ

Table S2. Multivariable Logistic Regression of Predictors of In-Hospital Mortality Among Patients 80 years or older Undergoing Left Atrial Appendage Closure *

	Odds ratios (95% Confidence intervals)	p-value
Age (per 1-year increment)	1.08 (0.94-1.25)	0.266
Female sex (vs. male)	2.30 (0.916-5.75)	0.076
Elective admission (vs. no)	1.18 (0.26-5.19)	0.831
Diabetes mellitus (vs. no)	0.93 (0.31-2.74)	0.895
Hypertension (vs. no)	0.33 (0.11-0.93)	0.036
Chronic kidney disease (vs. no)	1.84 (0.60-5.57)	0.284
ESRD (vs. no)	14.19 (3.36-54.91)	<0.001
Dyslipidemia (vs. no)	0.507 (0.19-1.32)	0.164
Chronic pulmonary disease (vs. no)	2.05 (0.758-5.53)	0.158
Atrial fibrillation (vs. no)	0.03 (0.003-0.31)	0.003
Prior MI (vs. no)	1.11 (0.24-4.94)	0.891
Prior cardiac surgery (vs. no)	1.08 (0.34-3.40)	0.898
Obesity (vs. no)	1.27 (0.27-5.84)	0.756
Prior CVA (vs. no)	0.6 (0.17-2.06)	0.416
Heart failure (vs. no)	1.29 (0.50-3.28)	0.601
Smoking (vs. no)	0.92 (0.34-2.50)	0.876
Peripheral vascular disease (vs. no)	0.37 (0.44-3.06)	0.355

*Variables included in the multiple logistic regression model were age, sex, admission status (elective vs. nonelective), heart failure, prior myocardial infarction, prior cardiac surgery, atrial fibrillation, prior cerebrovascular accident, chronic kidney disease, end stage renal disease, chronic pulmonary disease, smoking, diabetes mellitus, hypertension, dyslipidemia, obesity, and peripheral vascular disease.

Table S3. Multivariable Logistic Regression of Predictors of In-Hospital Stroke/TIA Among Patients 80 years or older Undergoing Left Atrial Appendage Closure *

	Odds ratios (95% Confidence intervals)	p-value
Age (per 1-year increment)	1.01 (0.93-1.08)	0.82
Female sex (vs. male)	0.92 (0.57-1.45)	0.707
Elective admission (vs. no)	0.21 (0.13-0.33)	<0.001
Diabetes mellitus (vs. no)	0.89 (0.52-1.49)	0.651
Hypertension (vs. no)	0.99 (0.51-1.95)	0.998
Chronic kidney disease (vs. no)	1.56 (0.92-2.64)	0.096
ESRD (vs. no)	1.28 (0.29-5.67)	0.742
Dyslipidemia (vs. no)	0.99 (0.62-1.59)	0.983
Chronic pulmonary disease (vs. no)	0.74 (0.37-1.46)	0.388
Atrial fibrillation (vs. no)	0.45 (0.008-0.24)	<0.001
Prior MI (vs. no)	0.41 (0.14-1.15)	0.092
Prior cardiac surgery (vs. no)	0.94 (0.52-1.70)	0.849
Obesity (vs. no)	1.021 (0.43-2.40)	0.962
Prior CVA (vs. no)	1.39 (0.85-2.25)	0.183
Heart failure (vs. no)	0.89 (0.53-1.46)	0.641
Smoking (vs. no)	0.5 (0.28-0.87)	0.015
Peripheral vascular disease (vs. no)	1.45 (0.74-2.80)	0.275

*Variables included in the multiple logistic regression model were age, sex, admission status (elective vs. nonelective), heart failure, prior myocardial infarction, prior cardiac surgery, atrial fibrillation, prior cerebrovascular accident, chronic kidney disease, end stage renal disease, chronic pulmonary disease, smoking, diabetes mellitus, hypertension, dyslipidemia, obesity, and peripheral vascular disease.